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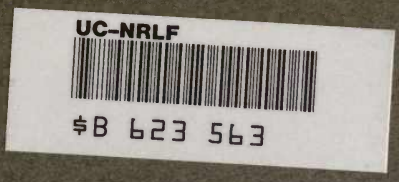

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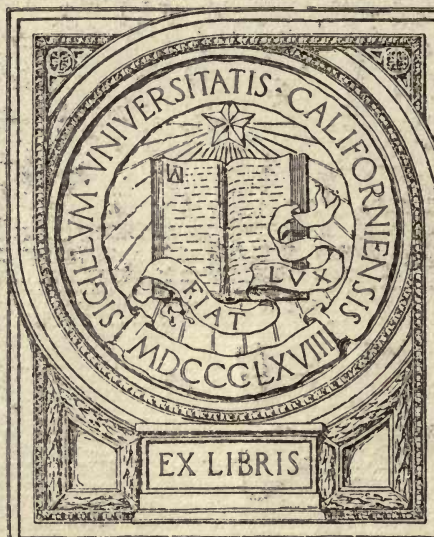
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PRESERVATIVE TREATMENT OF WOOD POLES

By R.V. ACHATZ

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PREFACE

The School of Electrical Engineering has received a number of requests for information on the subject of Preservative Treatment of Wood Poles. In answer to this demand for information which would be of immediate, practical value to the executives responsible for the construction policies of many of the utilities of the State, this circular has been prepared.

In presenting information on any phase of wood preservation, it must be remembered that this entire industry is of quite recent growth in the United States. Experience over a period of time long enough and covering a sufficiently wide range of conditions to establish a standardized practice has not been available in many of the applications of preservative treatment of timber. In the case of preservative treatment of wood poles, very few lines constructed of treated poles have reached the replacement stage and many lines of poles treated by some of the more recently developed processes have not reached a stage when the increase in life due to treatment can even be estimated with any accuracy.

The information presented in this circular is based upon such experience and data as are available at the present time and as far as warranted by the information, conclusions have been drawn and recommendations have been made. The conclusions and recommendations are in accordance with what is generally accepted as being the best practice at the present time but they must be regarded as provisional and subject to modification as experience accumulates and as the art of wood preserving progresses.

This circular is intended for the use of those who are responsible for the planning and supervision of pole line construction. For this reason the greater portion is devoted to a discussion of the methods and economics of pole treatment together with the results shown by inspections in various places rather than to a discussion of the causes of decay and the action of preservatives in preventing or retarding deterioration.

In compiling the circular, free use has been made of the available literature on the subject of wood preservation, particularly that referred to in the text. Much valuable information has been supplied through the courtesy of the various pole companies and manufacturers of preservatives. The writer is indebted to the pole using companies of Indiana who have willingly furnished information and especially to those mentioned in the text who by their interest and assistance made it possible to observe results of pole treatment under actual field conditions.

PRESERVATIVE TREATMENT OF WOOD POLES

I—INTRODUCTION

Wood poles have been used as a means of supporting the wires for electric service ever since the construction of the first overland telegraph line between Washington and Baltimore. As far as can now be foreseen, their use will continue as long as there is a supply of satisfactory pole timber, in spite of the extensive use of underground construction in congested districts and the development of steel and concrete substitutes.

The annual requirements for construction and replacement as shown by statistics compiled by the United States Forest Service for the year 1915 and for several years prior to 1911 are in excess of 4,000,000 poles. Of the poles purchased in 1915 about 61 per cent were cedar, principally northern and western, 16 per cent were chestnut and 13 per cent pine. The remainder were other timbers. Of the total number purchased, 41 per cent were used by telephone and telegraph companies, 35 per cent by electric light, power and street railway companies and 24 per cent by steam railways. The 1915 report showed a notable increase in the number of pine poles purchased. These were principally short length poles and were used by the electric light, power and street railway companies.

This enormous demand for poles has produced a constantly decreasing supply and constantly increasing costs of production as logging is carried on in more and more inaccessible districts. The large increase in cost to the user in the last decade has turned attention to the use of pole timbers formerly considered less desirable and to the use of preservatives to increase the life of poles of all classes. The importance of these matters has led to a survey of the conditions in Indiana and to the preparation of this circular on the subject of the Preservative Treatment of Wood Poles.

II—PRESENT STATUS OF POLE PRESERVATION IN INDIANA

The poles used in Indiana have been principally from the longer lived timbers as the state is located within a reasonable shipping distance from the source of supply of these timbers. Until recently little attention has been paid to the possibility of increased life from the use of preservatives and probably the great majority of the poles now in service received no treatment before setting. The increasing cost of poles in recent years, however, has directed attention to the advisability of using preservatives for new poles and to the possibilities of increasing the life of untreated poles, even after they have been in service for a considerable period.

In connection with the present study, data were obtained from about one hundred telephone, telegraph, electric light and power, street and interurban railway and steam railroad companies operating in various parts of the state. The estimated annual requirements of these companies is in the neighborhood of 40,000 poles. By far the greater number of poles used are northern white cedar though western or Idaho cedar has been used to some extent in recent years particularly where tall or straight poles are required. Some chestnut poles are used by the telegraph and other companies in the southern part of the State where the poles are cut from native timber near the place where they are used. Some other native woods are used, mostly by small rural telephone companies, but the number of poles is not large and the lines on which they are used are relatively unimportant. Cypress has been tried but experience has shown that its life is not as great as cedar or chestnut and its use has practically been abandoned.

Data on the use of preservative were not very complete but indicated that from 60 to 70 per cent of the poles used at the present time are being given some kind of preservative treatment. This estimate may be somewhat high as the information obtained came principally from the larger and more progressive companies. Practically every company furnishing information stated that it was using preservative treatment or was seriously considering its use.

As to the type of treatment in use, it was found that the telegraph companies and the steam railways, which follow the practice of the Western Union Telegraph Company, are using brush treatment. The American Telephone and Telegraph Company and the Bell Telephone Companies are using open tank and brush treatments. Practice among other telephone companies, electric light and power companies and street railway companies varies widely. Some are using no treatment, some brush treatment and some open tank treatment under one of the different specifications.

III—CAUSES AND PREVENTION OF DETERIORATION OF POLES

The causes of deterioration of pole timber after the pole has been placed in service may be the following:

1. Fire
2. Overload and Mechanical Injury
3. Damage by lightning
4. Attacks of insects and birds
5. Decay

Deterioration due to some of these causes, as fire and mechanical injury from accidents can not be foreseen and controlled. Failure of pole lines on account of overload may be prevented by proper design, the use of sufficiently large poles and by guying. Damage by lightning may be reduced by the installation of lightning wires. Damage

by birds is caused principally by two or three species of woodpecker which bore into the pole to secure food or to make nests. The number of poles that have to be replaced due to this kind of damage is small compared to other causes and no methods of control have been developed. In general birds do not attack poles which have not already been attacked by insects which form the food of the birds. Likewise, no methods of control of damage by insects, wood boring beetles and

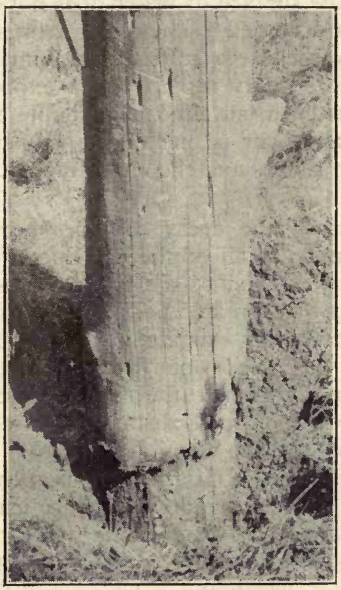

Fig. 1. Typical decay of untreated pole.

termites of white ants, have been developed except in so far as the methods used to prevent decay also prevent insect damage. By far the largest number of poles must be replaced due to decay or rotting of wood structure and it is with this form of deterioration that this circular is principally concerned.

Causes of Decay—Decay of timber is caused by fungus growth and by the action of bacteria. Fungi are low forms of plant life and are propagated by tiny seeds called spores. Most forms of fungus growth cause deterioration of the wood structure although there are some forms commonly called molds which may stain the wood but do not impair its strength. Fungus growth is started by the spores which are blown about by the wind and find lodgement on the surface and in the cracks of timber. Here they germinate and send out fine rootlets into the wood. By some little understood chemical process the wood fiber is dissolved and serves as food for the fungus, thus causing

decay. Different forms of fungi differ widely in their effect upon timber and this fact explains in part the great variation in the results of decaying action.

Certain conditions are necessary for the growth of the fungi, among them being a supply of food, which is the wood structure, air, moisture and a certain amount of heat. If any one of these is absent the growth is stopped or greatly retarded. It is well known that wood which is kept below the surface of water does not decay, which is due to the fact that air is excluded. The interior finish and furniture of a house do not decay because a sufficient amount of moisture is not present. Some timbers decay rapidly when exposed to the weather while others are affected to an almost negligible extent. This property of resisting decay in air is one of the properties that make the northern and western cedars and the chestnut, the most desirable and durable pole timbers.

The greater part of the decay of poles occurs at or near the ground line as at that point all of the conditions for fungus growth are present. *Figures 1, 2 and 3* are photographs of poles showing examples of the decay of untreated poles. Fig. 1 is a typical example of decay, the decayed portion starting just above the ground line and extending from six inches to one foot below the surface of the ground. In Fig. 2 in addition to the decayed surface at the ground line, there is a decayed spot some distance above, due to a defect in the pole. Fig. 3 shows the sap wood decayed to a distance of about a foot above the ground line. It is not common that decay occurs as far as this above the ground line but it may be caused by the growth of grass and weeds around the base of the pole.

The rapidity with which decay occurs depends greatly upon the character of the soil in which the pole is set. Poles set in broken rock or coarse gravel where dry air has access to the pole below the ground line are not usually subjected to as rapid decay as poles set in sand or loam which retains the moisture. It was stated by several companies that decay takes place quite rapidly in the clay soil of southern Indiana but no investigation was made of the cause.

Prevention of Decay—Decay may be prevented by removing any of the conditions that are favorable for fungus growth. It is clearly impracticable to control the temperature and the access of air to the timber of a pole line. Likewise, the control of moisture can be secured only to a very limited extent. Painting a structure exposed to the weather with oil paint has a preservative effect, due principally to the fact that moisture is excluded from the wood fibre. This method of preservation has little utility, however, when the timber is in contact with the earth. The only practicable method of arresting decay at the ground line is by rendering the substance of the wood unfit for food of the fungi. This may be done to a limited extent by charring, but the most effective way is by the use of chemicals.

Many processes have been developed and many chemicals have been used to prevent decay of wood, but only a small number have had any application to the treatment of poles. While copper sulphate, mercury bichloride, zinc chloride, and other chemicals have been used in Europe for pole treatment, the most important preservative is creosote oil or dead oil of coal tar. This preservative and some of the other products obtained in the process of distillation of coal tar are the only ones, the use of which will be considered here. The methods of application are discussed more fully in other sections of this circular. Brushing or spraying preservative over the

Fig. 2. Decay above ground line due to defect.

surface of the wood or dipping the wood into the preservative gives a superficial treatment without securing deep penetration of the preservative into the wood. Other processes are designed to inject the oil into the wood cells to a considerable depth below the surface. Among those processes are the hot and cold open tank treatment and the pressure treatments.

IV—PRESERVATIVES FOR POLE TIMBER

To provide effective protection of timber from decay, it is necessary that the wood preservative possess certain characteristics. It must have strong toxic or germicidal properties; it must have the ability to penetrate well into the wood fiber; it must not evaporate or

leach out of the wood and must be insoluble in water. It is also desirable that it should not be highly inflammable, that it should not cause deterioration in the strength of the timber, and that it should be non-poisonous. The preservatives obtained by the distillation of coal tar possess all of these qualities and so have found extensive application in the wood preserving industry. These preservatives include several grades of creosote oil and a number of other preparations sold under various trade names, but known collectively as carbolineums. Preservatives obtained from wood creosote are also on the market, but have not been used as extensively as the coal tar products.

The coal tar industry has been extensively developed in foreign countries, particularly in Germany, and before 1914 large quantities of the more refined preservatives were imported. Before 1914, the imported oils amounted to about two-thirds of the total amount used in this country but since that time the supply has been limited and in 1918 was only four per cent of the total. The coal tar industry has been growing rapidly in the United States and over 50,000,000 gallons of creosote oil are now produced annually. Domestic oils of all grades can now be obtained and many of the former distributers of foreign products are supplying domestic oils.

Fig. 3. Decay of sap wood above ground line.

Production of Preservatives from Coal Tar—Coal tar is a product obtained from bituminous coal in the process of manufacture of coal gas and of coke by the by-products process. Dead oil of coal tar or creosote oil, as it is more commonly known, is obtained by the distillation of coal tar. It contains three groups of constituents, (1)

those distilling below about 205 degrees centigrade called "light oils", (2) those distilling from about 205 deg. C. to about 255 deg. C. called napthalenes, and (3) those distilling above 255 deg. C. called anthracenes. Of these, the light oils which consist largely of the so-called tar acids are the most antiseptic but are soluble in water and also evaporate most easily. The other groups also have antiseptic properties and are more permanent when applied to wood as a preservative.

Wood preserving oils have been a secondary product of the coal tar industries. In Germany, dye materials are the principal product while in America before the war, the principal product has been soft pitch. Since the production of dyes required distillation up to a higher temperature than for the production of pitch, the German preservatives consisted largely of the higher boiling constituents of an anthracene nature. These preservatives are known as carbolineums while the American product containing lower boiling fractions obtained in the production of pitch is called creosote or creosote oil. Preservatives of the carbolineum type are now made in this country.

Some of the product marketed as creosote oil should properly be classed as "mixed creosote oil". It is produced by mixing with the pure creosote oil, undistilled coal tar or other products of coal or oil tar. On account of the shortage in the supply of creosote oil, there has been some tendency to accept the mixed oils for use in pressure treatments, particularly of railroad ties. It is doubtful if they would be satisfactory for poles where the more superficial treatments are used. Undistilled coal tar has been found to have little value as a preservative due to the fact that the tar does not penetrate into the wood, and the mixture of tar in the creosote oil would be objectionable for the same reason. Present opinion seems to be that mixed creosote oil can not be recommended for treatment of poles.

Specifications for Preservatives—Tests made on preservatives removed from timber after several years' service indicate that a large percentage of the fraction distilling below 205 deg. C. is lost while the fraction distilling above 270 deg. C. is practically permanent.* This experience has led to the preparation of specifications which require larger percentages of the higher boiling fractions. Various bodies interested in the production and use of structural timber have prepared specifications for preservatives and for methods of analysis of the oils. Among the specifications in use are those of the American Wood Preservers Association, the American Railway Engineering Association, the National Electric Light Association, the American Telephone and Telegraph Company, the United States Shipping Board Emergency Fleet Corporation and the United States Railroad Administration. These specifications differ somewhat in requirements but, in most cases, they specify the minimum specific grav-

*Tests on Telephone Poles are reported by Rhodes and Hosford, Preservative Treatment of Poles. Transactions of the American Institute of Electrical Engineers, Vol. XXXIV, 1915, page 2559.

ity of the preservative; the allowable amounts distilled between certain temperatures; the maximum amount of water; the amount and character of the residue after distillation and the method of performing the analysis. Several specifications for creosote oil are included in Appendix A of this circular.

Choice of Preservatives for Poles Treatment—The choice of a preservative for pole treatment depends upon the use, the method of application and the price. The price of coal tar creosote in the interior eastern part of the country ranged in 1918, from about eight to twenty-five cents per gallon, while the more highly refined preservatives ranged upward to eighty-five cents per gallon in barrel lots. For pressure treatments and for the hot and cold open tank process where large quantities of the preservative are absorbed by the wood and

Fig. 4. Brush treatment of poles.

where the penetration is sufficiently deep that leaching out of the lighter oils is not serious, the cheaper creosote oils are the only preservatives that can be used economically. For the superficial methods of application such as the brush treatment, the general practice has been to use the refined products having the higher boiling points, although some companies are using creosote oil with good results. While the heavier oils may not penetrate as deeply as the creosote, they have the advantage of being of a more permanent nature. The increase in cost of the treated pole due to use of more expensive preservative will not be large compared to the total cost of the pole. The

cost of the preservative is small and the cost of labor in applying the treatment will be the same.

Companies operating pole treating plants and those using large amounts of preservatives usually adopt a specification for preservatives under which they purchase their supply and are equipped with laboratories for making tests or can afford to have tests made to determine if the product supplied meets the specification. The small user, on the other hand, is not equipped to make tests and does not use preservative in sufficient quantity to justify having tests made. He can, however, protect himself by buying preservatives which are known to give satisfactory results and by dealing with companies which have established reputations for supplying materials of good quality.

V—METHODS OF TREATING POLES

Methods of treating timber may be classified as superficial and impregnation treatments. In the superficial treatments, the preservative is applied to the surface of the timber and only such penetration is secured as occurs naturally. Among these treatments are dipping, pouring, spraying and the brush treatment. Impregnation treatments use some means of injecting the preservative into the wood structure and penetration to a considerable depth is secured. The pressure tank process and the open tank process with hot and cold preservative are impregnation treatments.

Fig. 5. Brush treatment of poles showing use of long handled brush.
(Courtesy—Carbolineum Wood Preserving Co.)

The superficial treatments may be given on the job or in the pole yards of the smaller companies while the impregnation processes require elaborate plants which can not be operated economically by most pole using companies. These treatments are usually given at the yards of pole suppliers or at centrally located plants. The pressure tank treatment is used only for such timbers as decay rapidly above the ground line. The pole timbers used in Indiana, the cedars and chestnut, are very durable when exposed only to air so that butt treatment is sufficient. The cost of poles with the full length pressure treatment

is greater than butt treated cedar or chestnut and as they are little used in this territory, no discussion of the various processes of pressure treatment will be included in this circular.

Brush Treatment—The most common of the superficial treatments for poles is the brush treatment. This process differs materially from the ordinary method of application of paint with a brush as the preservative is flooded onto the timber and as much penetration secured as possible. The brush used should be a wire bound bristle brush, preferably with a long handle, and the preservative should be kept at a temperature between 150 and 225 degrees Fahrenheit during the application. Figs. 4 and 5 illutstrate the process of application of

Fig. 6. Brush treatment using mop.
(Courtesy—The Barrett Co.)

the preservative, the type of brush used in Fig. 5 being preferable to that shown in Fig. 4. A mop may be used in place of the brush as shown in Fig. 6. If desired, a shallow drip pan may be constructed to catch the preservative that runs off from the pole while the treatment is being applied. A heating apparatus may be constructed out of bricks and a coke or charcoal fire used as shown in Fig. 5 or the ordinary plumbers' furnace which is included in the equipment of most companies may be used. Two buckets should be used, one being heated while the preservative is being applied from the other.

The poles should be prepared for treatment as described in another section, especial care being taken to see that all of the fine inner bark is removed. Special attention should be paid to filling checks, knots and other defects. The pole should be treated from a distance of one foot above the ground line to a distance of two

feet below, as shown in Fig. 7. A two-coat treatment should be given, allowing one day between coats. If the soil is such that decay occurs in all parts of the pole below the ground line, the treatment should be continued to the bottom of the pole. Penetrations varying from a thin surface coating to about one-eighth of an inch may be secured depending upon the condition of the timber, the temperature and character of the preservative and the care used in application. For the convenience of those who may wish to use the brush treatment, a specification covering its application has been prepared and included in Appendix B.

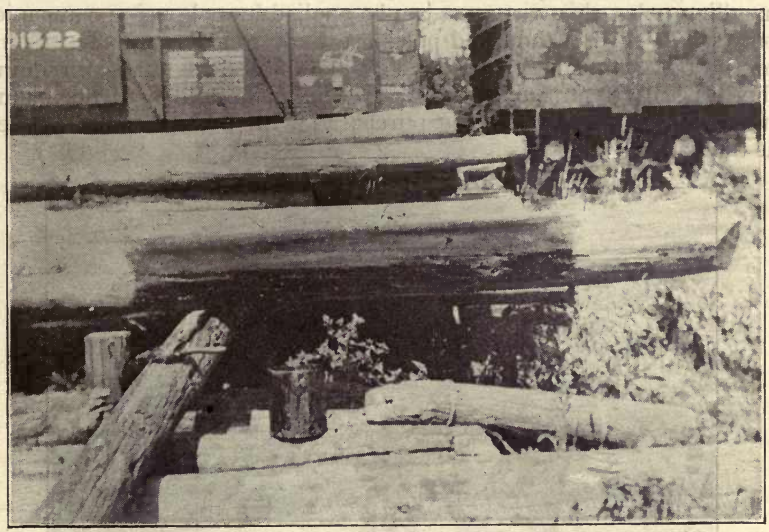

Fig. 7. Brush treated pole showing treated area.

Spraying Treatment—Where large areas of wood surface are to be treated as in the case of ship timbers, the spraying method has been found to be very economical. It has not been used to any great extent for pole treatment and it is questionable if the investment in the special equipment necessary would be justified for the ordinary pole using company. A hand pump with a special nozzle for creosote has recently been placed on the market, but little information is available as to its success. Fig. 8 illustrates this type of pump in operation.

Pouring Treatment—This method of treatment requires a tank that may be heated by a slow fire or by steam coils. The poles are skidded so that butts are above the tank and the hot preservative is poured over them with a long handled dipper, the excess dripping back into the tank. This method was used at one time by the Sullivan Telephone Company but was abandoned after an accident due

to a leaky tank which resulted in burning a carload of poles. The results of this method of treatment are quite good and are comparable to the results of good brush treatment or the open tank dipping treatment. Cost records show that the cost was about the same as the latter treatment furnished by the pole companies, and there seems to be little justification for the use of the pouring treatment for poles.

Open Tank Dipping Treatment.—The open tank dipping treatment consists of erecting the poles with their butts in a tank of hot preservative and allowing them to remain 15 minutes or longer if necessary. On account of the expense of the tank and the means of handling poles, this treatment can be applied by pole using companies only where several thousand poles are to be treated annually. Some of the pole companies have erected plants at their yards for doing this class of treatment as well as the hot and cold bath open tank treatment, and poles may be purchased with the treatment applied at the yard.

Fig. 8. Spraying treatment with hand pump.
(Courtesy—The Barrett Co.)

The results of the treatment so far as known have been good. It is more uniform than the brush treatment and the average penetration is somewhat greater. On the other hand, it is more expensive and this has caused some pole users to prefer the brush treatment. Specifications for the application of this treatment have been adopted by the pole companies and are designated as Specification "A" and Specification "AA", the only difference being that the preservative used in the former is carbolineum and in the latter creosote. These specifications are given in Appendix C.

Hot and Cold Bath Open Tank Treatment—The hot and cold bath open tank treatment gives the greatest penetration and consequently the greatest increase in life of any of the treatments commonly applied to poles of durable wood. The poles are erected with the butts in a tank of hot creosote which is maintained at a temperature of from 200 to 225 degrees F. After four to eight hours the poles are transferred to a cold bath for two to four hours. This may be done by transferring the poles to another tank filled with cold oil or by drawing off the hot oil and refilling the tank with cold oil. During the hot bath the air and moisture in the wood are expelled and the wood cells expanded. When the cold bath is applied the preservative is drawn into the wood. The attempt is made to secure as deep penetration as possible, but it has been found to be impossible to penetrate into the heart wood. Complete impregnation of the sap wood is the maximum that can be secured. Fig. 9 illustrates a charge of poles being treated at the yard of one of the pole suppliers.

The two specifications for the application of this treatment are those of the American Telephone and Telegraph Company and of the pole companies, the latter known as Specification "B". These specifications are reproduced in Appendix D. The two specifications differ in several respects, but the most important difference is in the requirement for penetration. The "Note" to Specification "B" requires at least 75 per cent of the poles to have a penetration of one-half of the thickness of the sap wood. The A. T. & T. specification requires penetration of one-half of the sap wood on all poles except where the sap wood has a depth greater than one-half inch, in which case a penetration of one-fourth inch is required.

The results of this treatment have been very satisfactory as regards prolonging the life of poles. It is the most expensive butt treatment on account of the time required and the amount of preservative absorbed. It is particularly suitable for heavy poles and permanent lines.

Preparation of Poles for Treatment—The success of any method of treating poles depends upon the proper preparation of the poles for treatment. Poles should be seasoned properly. They should be piled on skids above the surface of the ground and above vegetation and in such a manner as to allow free circulation of the air. Green or partly seasoned poles should not be treated except by the hot and cold open tank process, where the hot bath acts to drive off the moisture. Poles wet by rain or snow should be allowed to dry thoroughly before the preservative is applied. All dirt and foreign material must be removed. There is some difference of opinion as to whether the butt should be shaved completely. There is no doubt that special care must be used to remove all of the fine inner bark. A large number of cases of failure of the treated layer could be

traced to adhering bark which absorbed the preservative and prevented penetration into the wood. Any unsound wood should be cut away.

During and after treatment poles should be handled carefully to prevent damage to the treated layer. They should not be dragged over the ground and cant hooks or pole tongs should not be used on or just above the treated portion. If borings are made to inspect the depth of the penetration the holes should be filled with hot creosote and plugged with a treated plug. Linemen working on treated poles should be instructed to avoid setting their spurs into the treated portion of the pole.

Treatment of Tops and Gains—Decay occasionally takes place at the top of the pole or at the gains where the end grain of the wood is exposed. This may be prevented by the application of a two-coat brush treatment with hot preservative when the poles are framed.

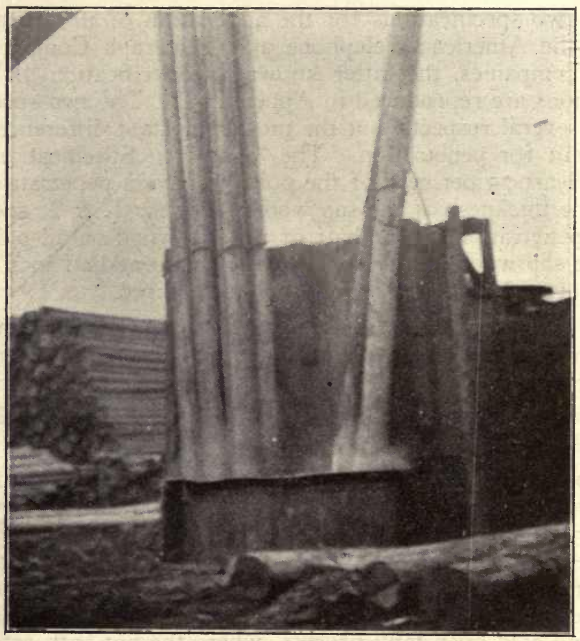

Fig. 9. Open tank treatment.

Precautions in Handling Preservatives—Hot creosote preservatives and the vapor from hot preservatives will often produce a burning sensation or even blisters if it comes into contact with the skin. Those engaged in treating poles may avoid contact with the hot oil or vapor by wearing gloves and by working from the wind-

ward side so that the vapor is blown away from rather than toward the workman. The application of vaseline to exposed parts of the hands and face will afford some protection against burning the skin. As far as known no serious results come from exposure, but disagreeable and painful irritation is sometimes experienced.

The ordinary precautions should be observed when a furnace or fire is used to heat the creosote to prevent fire and care should be used in handling the hot preservative to prevent spilling the hot material over workmen engaged in the application or working in the neighborhood.

VI—ECONOMICS OF POLE TREATMENT

When several methods of construction may be used differing in cost and expectation of life, one of the most important questions to be decided in making a selection is "which will pay best in the long run?" In some cases the decision can be made entirely on the basis of cost in the long run, while in other cases there are considerations which can not be evaluated in dollars and cents which must be given consideration and which may even overbalance an advantage in cost. In the case of pole treatment, the cost is of primary importance, although there sometimes are other factors which enter. In order to throw light on the economic features of pole treatment, some data are presented as to the cost and economy of untreated poles and poles treated by the different methods. It must be remembered that the figures given may not be applicable to particular cases as differences in the cost of treatment and the life of poles would change the results.

The cost of treating poles varies over wide limits, depending upon the method of treatment, the number of poles treated at one time, the amount of preservative used, the cost of preservative, the cost of labor, the amount of handling of the poles during treatment and other factors. In the case of brush treatment, the conditions vary so much that it is almost impossible to give accurate cost data. The cost may run from twenty to thirty cents for small and light poles to one dollar or more for large poles. The pole companies which operate plants for treating poles have a schedule of charges depending upon the specification under which the treating is done and the size of the pole. At present (September, 1919) the charge for Specification "AA" treatment by dipping in hot creosote ranges from $0.40 for a 4"-20' pole to $4.25 for an 8"-45' pole. The range of cost for Specification "A" carbolineum dip treatment is from $0.50 to $5.25, and for Specification "B" hot and cold treatment from $0.80 to $6.50 for the same sizes of poles. These prices are for treating Northern White Cedar poles.

Additional Life Necessary to Justify Treatment—If comparisons are to be made between construction methods involving different

first costs and different expectations of life, it is necessary to reduce the cost data to some common basis. The common basis for comparison in the case of poles is the annual cost of service. Annual cost of service includes the interest on the investment or first cost, the amount that must be placed in a reserve for replacement so that the money expended for first cost is available at the end of life, the amount that must be paid annually for maintenance and the annual cost of operation. The cost of maintenance and the operating expense do not change whether the pole is treated or not, so that interest and depreciation, or payment into replacement reserve, are the only factors that have to be considered in making comparisons.

A convenient method of making comparisons between untreated poles and poles treated by various methods is to determine the annual cost of service of untreated poles and then determine the minimum life of treated poles to give the same annual cost. The difference between this minimum life of the treated poles and the life of untreated poles gives the increase in life necessary to justify treatment. This increase in life necessary to justify treatment may then be compared with the expected increase in life due to the use of treatment as shown by experience, to determine if it is economical to use the treatment.

The results of computations to determine the increase in life necessary to justify treatment are given in Table I. Four common sizes of poles have been selected and the data prepared for treatment by the brush method and by tank methods, While the costs might differ in specific cases from those given in the table, the variation would be nearly proportional and the results would not be changed materially. The costs given are based upon prices as of September, 1919. Prices on poles are based on quotations in carload lots f. o. b. Indianapolis as a central point in Indiana. Labor and other costs are based upon present rates of wages and other expense. No general expense as administration, engineering, interest or insurance, is included. The costs of brush treatment are based on a study of the cost of treating a certain group of poles and on other information available. Costs of the tank treatments are the charges made for the treatment by the pole suppliers.

The estimated life of untreated poles is based upon average conditions in Indiana soils and the amount of depreciation is computed on a sinking fund basis with interest at 4 per cent compounded semi-annually. Interest on the investment is computed at 6 per cent. The life of the treated poles necessary to justify treatment is approximate, being taken at the half-year nearest the actual figure.

TABLE I.—Increase in Life Necessary to Justify Treatment

Untreated Poles				
Size of Pole:				
Length	20′	25′	30′	35′
Top	5″	5″	6″	7″
Cost in Place (Not stepped or painted)	$2.80	$4.37	$8.35	$15.85
Life in Years	12	14	15	16
Annual Charge:				
Interest 6%	$ .168	$ .262	$ .501	$ .951
Depreciation, 4% sink. fund	.186	.239	.417	.724
Total	$ .354	$ .501	$ .918	$1.675
Brush Treated Poles				
Cost in Place	$3.14	$4.79	$8.94	$16.69
Annual Charge:				
Interest, 6%	$ .188	$ .289	$ .536	$1.001
Depreciation, 4% sink. fund	.166	.212	.382	.674
Total	$ .354	$ .501	$ .918	$1.675
Life in years necessary to justify treatment	14.5	16.5	17	17.5
Tank Dipped with Creosote (Specification "AA")				
Cost in Place	$3.30	$4.97	$9.45	$17.70
Annual Charge:				
Interest, 6%	$ .198	$ .298	$ .567	$1.062
Depreciation, 4% sink. fund	.156	.203	.351	.613
Total	$ .354	$ .501	$ .918	$1.675
Life in years necessary to justify treatment	15.5	17.5	18.5	19.5
Tank Dipped with Carbolineum. (Specification "A")				
Cost in Place	$3.45	$5.17	$9.95	$18.35
Annual Charge:				
Interest, 6%	$ .207	$ .310	$ .597	$1.101
Depreciation, 4% sink. fund	.147	.191	.321	.574
Total	$ .354	$ .501	$ .918	$1.675
Life in years necessary to justify treatment	17	18.5	20.5	21
Open Tank Hot and Cold Treatment				
Cost in Place	$3.75	$5.57	$10.60	$18.85
Annual Charge:				
Interest, 6%	$ .225	$ .334	$ .636	$1.131
Depreciation, 4% sink. fund	.129	.167	.282	.544
Total	$ .354	$ .501	$ .918	$1.675
Life in years necessary to justify treatment	19.5	21.5	23	22

For the sizes of poles given, it will be noted that Table I shows that an average increase in life of about two years will justify brush treatment. An average increase of 3½ years will justify the creosote dip treatment, of five years will justify the carbolineum dip treatment, and 7½ years will justify the hot and cold open tank treatment. Table II is a summary of the results of Table I and a comparison with the expected increase in life that may be expected to result from treatment.

TABLE II.—Summary of Necessary Increase in Life to Justify Treatment and Expected Increase in Life From Use of Treatment

Type of Treatment	Increase in life necessary to justify treatment	Increase in life which may be expected from use
Brush Theatment	2 years	3 to 5 years
Creosote Dip (Specification "AA")	3.5 years	4 to 6 years
Carbolineum Dip (Specification "A")	5 years	No information available
Hot and Cold Open Tank (Specification "B")	7.5 years	More than 11 yrs. (A.T.&T. Spec'n)

The increase in life which may be expected from treatment given in Table II for brush treatment is taken from the results of the inspections of poles described in another section of this circular and from other information. The increase for the creosote dip treatment is also taken from the results of the inspection. No information is available as to the effectiveness of the carbolineum dip treatment. Experience of the American Telephone and Telegraph Company with hot and cold open tank treated poles in experimental lines indicate that considerably longer than eleven years' increase in life may be expected.

Factors Other than Cost which May Influence Selection—The figures presented in Tables I and II are based on the bare cost of replacement of the pole and include no expense for transferring the wire and fixtures from the old to the new pole in making the replacement. There is, likewise, the factor of interruption to service that must be considered. This may amount to little or nothing on a rural telephone line where replacement may be made without interfering with the operation of the line. On the other hand, the replacement of a high pole on an important high tension power transmission line may involve serious interference with the continuous operation of the line or extra cost on account of having to do the work on Sunday. In such a case, even if the increased life barely justified the

treatment, the reduction in interruptions to service would be of considerable advantage. In other cases, the cost of transferring wires, cables, cable terminals, transformers or guys from the old pole to the new may justify the use of treated poles even if there were no advantage at all from the standpoint of cost when only the bare cost of the pole is considered.

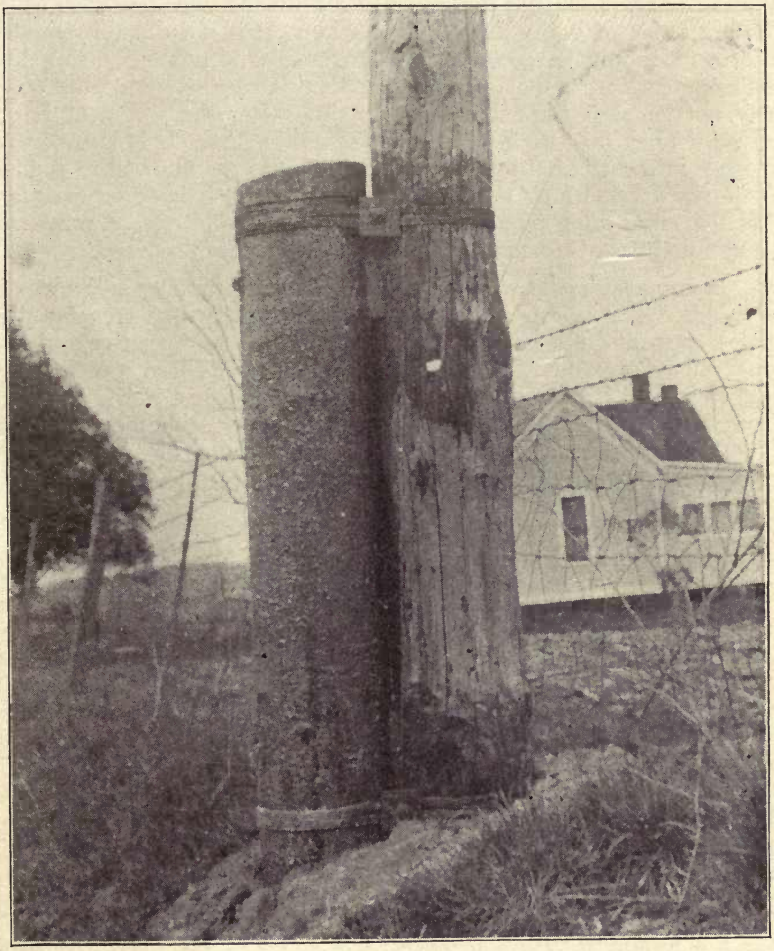

Fig. 10. Reinforcement with creosoted stub.

Selection of Type of Treatment to be Used—From the data given above, it can be seen that the use of pole treatment can be justified from a cost standpoint. The selection of the type of treatment must depend somewhat upon local conditions. For temporary

lines where the life of the line does not exceed the life of the poles, it may be advisable to use untreated poles, especially if the poles are not likely to be reused. Where first cost must be kept down on permanent lines and for small companies which use only a few poles annually the brush treatment has the advantage. The tank dipping treatment with creosote will be justified if a considerable number of poles are to be used and the pole using company does not wish to go to the trouble of doing the brush treating. It is not certain that this treatment should be recommended to smaller companies using less than one carload of poles annually. In this case, some of the poles may not be used for a considerable time after the shipment is received. They may even be held for several years. It is known that brush treatment is not as effective if the poles are allowed to remain in the yard for a long time after treatment and it is to be expected that the same thing would be true of the creosote dipped poles, although no direct information on this point has been secured.

It is questionable whether the carbolineum dipping treatment is advisable. The cost of this treatment is more than the creosote dipping treatment on account of the higher cost of preservative and if a longer lived treatment than the creosote dip is desired, the hot and cold treatment is to be preferred. The great increase in life obtained from the use of the hot and cold treatment will justify this treatment for the more important lines, particularly those using large and heavy poles, where the life of the line is expected to exceed twenty years.

VII—PRESERVATION OF POLES ALREADY IN SERVICE

By far the greater number of poles in service at the present time have been set without preservative treatment. On account of the fact that many of the poles in the older lines are coming to the end of their life and must soon be replaced, much interest has arisen in the possibility of deferring the replacement. A method which has been used with good results and which is familiar to pole using companies is "stubbing" or reinforcement by setting a stub by the side of the weakened pole and binding the pole to the stub by wire. Fig. 10 illustrates this method of reinforcement. The stub is a short piece of pole which has been given a creosote treatment before setting. This method is so well known that no further description or discussion need be given here.

Use of Preservative Treatment on Poles in Service—The question has been asked a number of times as to whether it is economical to treat poles that have been in service a number of years but which have not been weakened to the extent that reinforcement is needed. This has been done by a number of companies with good results. The process consists of digging the earth away from around the foot of the pole to a depth of 12 to 18 inches and cutting away

all decayed wood. This work should be done during the dry part of the summer season and the poles should be allowed to stand for two or three weeks with the wood exposed to the air to dry out all of the surface moisture. After the wood is well dried a two-coat treatment is given with a brush. The cost is somewhat greater than the cost of brush treatment on account of the digging and refilling around the pole. Some increase in life will result which will probably justify the expense.

The Sullivan Telephone Company applied this treatment to a number of poles in its city plant in 1916. A series of six of these poles were inspected about three years after they were treated. Out of the six poles inspected, two were practically sound and a third was sound on the outside, although the center of the pole had decayed, leaving a ring of sound wood four or five inches thick. Three poles showed some decay. The wood of these three poles was sound around the greater part of the surface, but decay had taken place in narrow pockets extending quite deeply into the pole. From the general condition of the poles inspected it would seem that from three to five years had been added to their life.

Reinforcement of Poles with Concrete—A matter which has received much attention recently is the question of concrete reinforcement of poles. There are two points in connection with the use of concrete which must be carefully distinguished, the effect of the concrete upon the decay of the timber and the strength added by the reinforcement. There is much reason to doubt if the life of a pole is increased by setting it in concrete. In fact, experience with lines where the poles have been set in concrete seems to indicate that conditions may be provided by the concrete jacket which allows decay to progress more rapidly than on untreated poles set in earth. This may be due to the fact that it is difficult to prevent water entering between the pole and the concrete, and once having entered it does not evaporate rapidly, thus providing the moisture necessary for fungus growth. There is no doubt that it is not economical to set new poles in concrete with the expectation of increasing the life. The cost is high in comparison with other methods of treatment and the preserving effect is, at the best, of doubtful value.

While it is doubtful if concrete will prevent timber from decaying as rapidly as when set in earth, there is no doubt that concrete reinforcement will give added strength to a pole which has been weakened by decay. Although the point of greatest stress on the material of a new pole which is subjected to a lateral load is usually somewhat above the ground line, most failures of poles in service occur at the ground line due to the reduction of the size of the pole. Because of this, reinforcement which adds strength at the weakest part of the pole will give some increase in life. The strength of the reinforced pole may not, however, be as great as that of a new pole set in earth, as the concrete forms a rigid support, and fracture is

more likely to occur with a given load than when the pole is set in earth, which will give somewhat under load. In general concrete reinforcement must be looked upon, not as a means of stopping decay, but of transferring decay to a portion of the pole not yet attacked and of giving added strength to a pole weakened by decay.

Fig. 11. Concrete butt reinforcement.

There are several patented processes for applying concrete reinforcement to poles and other processes are in use locally. Fig. 11 is a photograph of a pole to which a concrete reinforcement has been applied. In this type of reinforcement, the earth was excavated and the pole was given a preservative treatment similar to that described for treating poles already in service, except that the treatment was carried above the top line of the concrete jacket. A reinforcement of some kind, either wire netting or rods, was put into place and concrete poured into a form which extended about a foot above the ground line. A sloping roof was formed on the jacket and particular attention was paid to securing a good joint between the concrete and

the pole. A coating of pitch was applied to the roof after the concrete had set.

Cost records indicate that the cost of such a concrete reinforcement is between $4.00 and $5.00 per pole. On account of the high cost it can be justified only where the cost of replacement of the pole is great. Such cases would be for high poles on power transmission lines where replacement means interruption to service or for heavy junction poles in telegraph, telephone and power distribution lines where the cost of transferring the equipment is large. It can not be justified for light lines or for short poles.

Fig. 12. Example of bad practice in the use of concrete.

Fig. 12 is shown to illustrate the misuse of concrete. This pole, which was found in the lines of one of the smaller telephone companies, had a concrete jacket which evidently had been placed in three distinct sections. The concrete was badly cracked and there was an opening between the concrete and the pole. The wood inside the jacket was so badly decayed that replacement of the pole was necessary. The cost of a new pole at the time the concrete was placed would probably have been little more than the cost of the concrete, and the life of the new pole would certainly have been much greater than the life added by the reinforcement.

VIII—INSPECTIONS OF TREATED AND UNTREATED POLES

In connection with the study of pole treatment, inspections were made in several parts of Indiana to obtain first hand information as to the experience with preservative treatment. It was found to be quite difficult to locate pole lines that would give data of any value. Many lines of treated poles have been set so recently that their condition gives no indication of the effectiveness of the preservative treatment, while on the older lines it is difficult to get information as to date of erection, preservative used and details of the method of treatment. Also, it is almost impossible to find locations in existing pole lines where treated and untreated poles have been planted in the same soil at the same time.

However, it was possible to find a number of examples in various parts of the State, which give some valuable information as to the effectiveness of several methods of treatment. In some cases the data are incomplete and the averages deduced from the results might be changed somewhat if a larger number of poles were included. Even if allowance is made for a possible variation, the data show an undoubted increase in the life of the poles when proper treatment is given and it was possible to study the causes of failure on many poles where the treatment had not been applied properly. It might be possible to compare the results with those obtained in other investigations, but such comparison would be of little value as the conditions of soil and moisture are different and the methods of determining the amount of decay can not be checked.

The method of inspection consisted of digging away the earth from around the pole to the depth necessary to determine the amount of decay. The decayed wood was cleared away and the reduction in circumference of the pole at the point of greatest decay was determined by measurement. In case of treated poles where the treated layer was nearly sound, the pockets where decay had commenced were explored and the depth and width of the decayed spot determined. An equivalent reduction in circumference was computed from the size of the decayed spot and the dimensions of the pole. In most cases, twelve poles were selected in a group set as nearly consecutively in the line as possible. It was necessary to omit poles which were for some reason inaccessible or which had not been set at the same time as the rest of the line and also poles which differed in character from the others in the line, as an untreated pole in a line of treated poles. In a few cases a smaller number than twelve poles were inspected where that number were not available. Poles which were inspected were branded with a square on the road side of the pole five feet above the ground line for future identification and study.

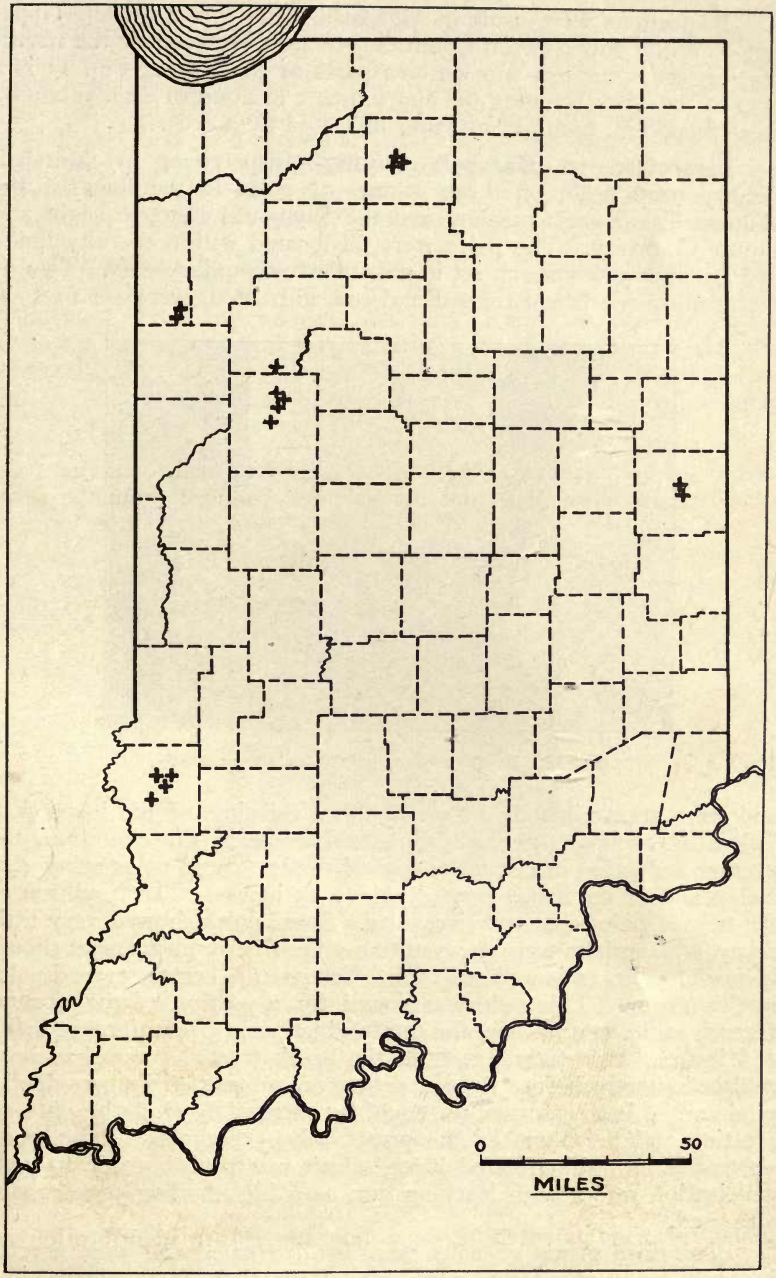

Fig. 13. Locations of poles inspected.

Inspections were made in Marshall, Randolph, Sullivan, Tippecanoe, White and Newton Counties, representing roughly the northern, eastern, southern and western parts of the State. Fig. 13 is a map of the State showing the approximate location of each group of poles inspected, each group being indicated by a cross.

Inspection in Marshall County—Inspections in Marshall County were made on three groups of poles in the lines of the Winona Telephone Company and the Plymouth Electric Light and Power Company. The poles were all located within the city limits of Plymouth and were all set in a soil that was quite sandy. Two of the groups, one brush treated and one untreated, were set in 1908

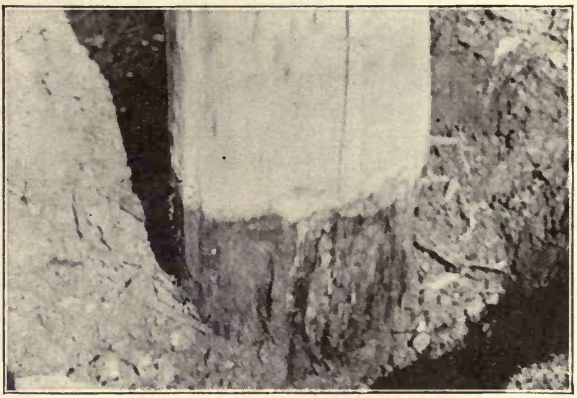

Fig. 14. Brush treated pole after eleven years.

and were approximately 11 years old at the time of the inspection. Taken as groups, there was little difference in the condition, the average reduction in circumference of the untreated poles being 4.25 inches and of the brush treated poles 4.23 inches. The condition of the treated poles was very irregular. Some poles showed very little decay, while others were decayed to a stage where replacement should be made. Fig. 14 is a photograph of one of the best preserved poles in this group. This pole was sound for a portion of the circumference at the ground line, the total reduction in circumference being 1½ inches. One treated pole in the brush treated group had been replaced shortly before the inspection on account of failure due to pipe rot. Little information could be secured beyond the date of erection and the name of the preservative. Samples of the wood showed a very thin treated layer, which was probably due to poor penetration rather than leaching out, as a high boiling preservative was used.

The third group of poles were brush treated and were erected in 1914, being about five years old at the time of the inspection.

Exact information as to the preservative used and the manner of application could not be secured. Only one sound pole was found out of the twelve inspected. The maximum reduction in circumference was 1.5 inches and the average including the sound pole was 0.51 inches and 0.60 inches omitting the sound pole. The treated layer was quite thin and in most cases decay had started pretty well around the entire circumference of the pole. The treatment had practically reached the end of its life as a protection to the wood.

Inspections in Randolph County—Two groups of poles were inspected in Randolph County in the lines of the Eastern Indiana Telephone Company and the Citizens' Light, Power and Water Company. One group located north of the city of Winchester was erected in 1916, and had been treated at the pole yard by the Specification "AA" creosote dipping treatment. Seven of the twelve poles

Fig. 15. Brush treated pole showing result of defect above ground line.

were sound. Decay in one pole had started where borers had penetrated below the treated layer and in another pole where a knot near the ground line had decayed. Of the remaining three poles showing decay, the decay had just started and had reached a depth of about 1/32 inch for two or three inches around the circumference. The average reduction including all poles was 0.08 inches and omitting sound poles was 0.30 inches. The increase in life of the poles may be expected to be about the same as that obtained by first-class brush treatment in other locations.

The second group consisted of six poles inside the city limits of Winchester. These poles had been given a brush treatment with carbolineum applied cold and were erected in 1912, being seven years

old at the time of the inspection. The average reduction in circumference was 1.08 inches. Fig. 15 is taken from a photograph of one of these poles and shows clearly the effect of a defect near the ground line. An axe cut about four inches above the ground had permitted decay to start and a strip the width of the cut had decayed down the side of the pole.

Inspections in Sullivan County—Inspections in Sullivan County were made on three groups of poles in the toll lines and one group in the city lines of the Sullivan Telephone Company. All of the poles in these groups were treated. No untreated poles of approximately the same age could be located. The soil in this location is the clay soil which is found over a considerable portion of southern Indiana. The first group inspected consisted of twelve poles in the New Lebanon-Merom toll line and was located just outside the village of New Lebanon. This line was eight years old, having been set in 1911. The poles were given a single coat of cold carbolineum which was applied on the job just before the poles were set. The inspection showed an average reduction of 3.23 inches and indicated that little if any benefit had been secured from the treatment. Samples of the wood showed little penetration and it is probable that the thin treated layer was scraped and damaged to some extent when the poles were set.

The second group of poles was located just north of the town of Shelburn in the Hymera toll line. These poles were erected in 1912 and were treated by the pouring process described in another section. Of the twelve poles inspected, only one was found to be sound. The average reduction in circumference was 1.54 inches including and 1.68 inches omitting the sound pole. The reduction on individual poles ranged from ½ inch to 3⅓ inches. The failure was typical of treated poles. In most cases the treated layer appeared perfectly sound but decay was found beneath. In four of the twelve poles white ants were found in the wood beneath the treated layer.

The third group of poles in the Fairbanks toll line, north and west of Shelburn, was erected in 1914, the poles being nearly five years old at the time of the inspection. These poles had been treated at the pole yard with hot creosote dipping treatment known as Specification "AA". On four of the twelve poles the decay was just starting and in one case the failure was due to fine inner bark which had not been removed before the treatment was applied. The reduction was very small in most cases, the largest being due to a pocket ¼ inch deep by 8 inches wide. The average reduction was calculated to be 0.2 inches including the decayed poles only, and 0.01 inch including the sound poles. It is probable that a considerable number of these poles were just at the stage where decay was getting a foothold in the wood.

The group of poles in the city lines consisted of poles that had been treated several years after they had been set and the results of the inspection have already been discussed in the section on "Preservation of Poles Already in Service".

Inspections in Tippecanoe and White Counties—Several groups in the northern part of Tippecanoe and one group in the extreme southern part of White County were inspected. The lines involved were the Brookston-LaFayette toll line of the Prairie Telephone Company, the LaFayette-Soldiers' Home-Battle Ground line of the LaFayette Telephone Company and the Tippecanoe County Farm extension of the Otterbein Light and Power Company's power transmission line. The majority of these poles were set in a sandy loam soil, although in some places in the lower ground sand predominated.

Fig. 16. Brush treated pole after five years.

Three groups of poles were brush treated and were erected about four years before the inspection. These poles were treated with two coats of carbolineum. Out of the 36 poles inspected, 28 were found to be sound. Fig. 16 is taken from a photograph of one of the sound poles and it will be noted that there is no evidence of decay. Of the eight poles showing decay, it was possible to determine the cause of the failure of the treatment in seven cases. In two poles decay started at season checks and in one at a knot. The fine inner

bark had not been removed from two poles and prevented the preservative from penetrating the wood. In two poles wood borers had allowed decay to start beneath the treated layer. The average reduction in circumference including all poles was 0.17 inches, and including only the poles which had started to decay was 1.52 inches.

One group of untreated poles erected eight years before the inspection were interspaced for a portion of the distance with one of the groups of treated poles. The average reduction in circumference was 2.83 inches. White ants were found in one pole.

Another group of untreated poles was erected three years before the inspection was made. Every pole showed some evidence of decay, and, while there were no deep pockets, a spongy layer of decayed wood extended entirely around the pole at the ground line. When this spongy layer was scraped away the reduction in circumference was found to range from ¼ inch to 1¼ inches. The average reduction was 0.58 inches.

Inspection in Newton County—The inspections in Newton County covered two small groups of poles. One of these groups consisted of untreated poles and was erected about six years before the inspection. The other group of brush treated poles was set about one year later than the untreated poles. The poles were in the lines of the Interstate Public Service Company and the Western Indiana Telephone Company just outside the town of Goodland. This represented the best example found of treated and untreated poles of approximately the same age and set in the same soil. Unfortunately the number of poles in the parallel was small, the treated poles being limited to a short section of line that was rebuilt shortly after the building of the transmission line. The average reduction in the circumference for the six untreated poles was 2.43 inches. Four of the six treated poles were sound. The average reduction in circumference was 0.18 inches including sound poles and 0.55 inches omitting sound poles. Of the two poles which had started to decay, one was found to have failed because of bark which had not been removed and one due to the work of wood borers.

Conclusions from Inspections—The results of the inspections, showing number of poles, per cent sound and average reduction in circumference at the ground line are summarized in Table III. A study of the data leaves no doubt that the life of poles will be increased by proper treatment. In most cases where treatment failed to protect the poles from decay, the failure could be traced to improper treatment or to causes which the treatment could not control. In the other cases of failure no evidence was secured to indicate that the proper treatment had been given. On the other hand, in all cases where it was known that the treatment was properly applied, a considerable period of arrest of decay and consequent prolonging of life was evident.

TABLE III.—Summary of Inspections of Treated and Untreated Poles

Group and location	Preservative and treatment	Number Inspected	Age in Years	Poles sound		Decrease in circumference	
				Total	Per cent	Including sound poles	Omitting sound poles
Marshall County	Carbolineum Brush Tr.	12	11	0	0	4.23	4.23
	Brush Tr.	12	5	1	8.3	.51	.60
	Untreated	12	11	0	0	4.25	4.25
Randolph County	Specification "AA"	12	3	7	58.3	.08	.30
	Carbolineum Brush Tr.	6	7	0	0	1.08	1.08
Sullivan County	Specification "AA"	12	5	8	66.7	.01	.20
	Carbolineum Dipper Tr.	12	7	1	8.3	1.54	1.68
	Carbolineum Brush Treat.	12	8	0	0	3.23	3.23
Tippecanoe and White Counties	Carbolineum Brush Treat.	36	4–5	28	77.8	.17	1.52
	Untreated	12	8	0	0	2.83	2.83
	Untreated	12	3	0	0	.58	.58
Newton County	Carbolineum Brush Tr.	6	5	4	66.7	.18	.55
	Untreated	6	6	0	0	2.67	2.67

Failure of the brush treatment came from the use of only one coat, from the use of cold preservative and consequent lack of penetration, from the failure of the preservative to enter season checks or from the opening of checks after the treatment was applied. Imperfections near the ground line, such as axe cuts and knots, were responsible for some failures as was adhering inner bark which prevented the preservative from reaching and penetrating the wood and so allowed decay to commence. Where the two-coat brush treatment with hot preservative had been used there was undoubted evidence that the starting of decay was delayed several years.

The inspections of poles treated with Specification "AA" creosote dipping treatment were limited to two groups. The results are comparable with the results obtained by brush treatment applied under the very best conditions. The question of which treatment is adopted depends largely upon the preference of the user. The practice of buying the treated poles has the advantage that the user does not have to apply the treatment and a more uniform result is secured. On the other hand, as shown in the discussion of the economics of pole treatment, the cost is greater and a somewhat greater increase in life is necessary to justify the additional cost.

It was impossible to get first hand data on poles with the hot and cold bath tank treatment. This process is the most expensive

and experience in other parts of the country shows that it gives the greatest increase in life of any of the butt treatments. This will be referred to again in connection with discussion of the results of other investigations.

From information available at the present time, it is not possible to give definite figures on the increase in life due to the use of preservative. Even where specially prepared groups of experimental poles have been set, the experiment has not progressed to the point of complete replacement of all poles having different types of treatment. It is possible, however, from a consideration of the period of arrest in decay to estimate the increase in life with fair accuracy. Thus, if the beginning of decay is arrested for a certain number of years it may be assumed that the same number of years is added to the life of the pole. This estimate is based on the assumption that treated poles do not decay more rapidly after decay has once com-

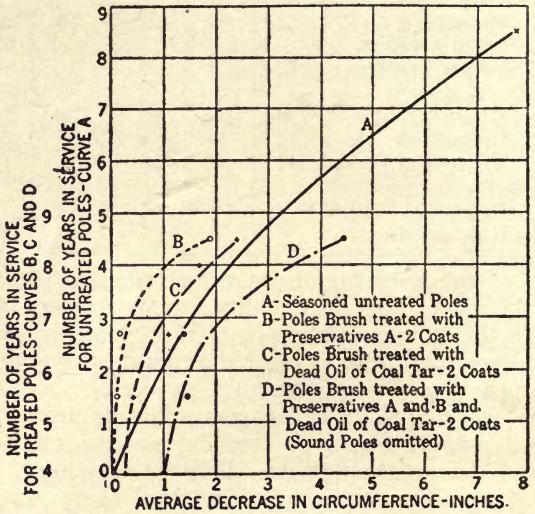
NUMBER OF YEARS IN SERVICE FOR TREATED POLES-CURVES B, C AND D
NUMBER OF YEARS IN SERVICE FOR UNTREATED POLES-CURVE A
AVERAGE DECREASE IN CIRCUMFERENCE-INCHES.
A
B
C
D
A-Seasoned untreated Poles
B-Poles Brush treated with Preservatives A-2 Coats
C-Poles Brush treated with Dead Oil of Coal Tar-2 Coats
D-Poles Brush treated with Preservatives A and B and Dead Oil of Coal Tar-2 Coats
(Sound Poles omitted)

Fig. 17. Rate of decay of treated and untreated chestnut poles.

menced than do untreated poles, which is borne out by evidence gathered by the engineers of the American Telephone and Telegraph Company. Fig. 17 is taken from a paper by F. L. Rhodes and R. F. Hosford in the Transactions of the American Institute of Electrical Engineers, Vol. XXXIV, 1915, p. 2576. This figure, which shows the reduction in circumference of chestnut poles, indicates that brush treated poles do not decay more rapidly than seasoned untreated poles. Approximate estimates of increased life were made from the data of Table 3, and were used in Table 2, but the figures may be subject to considerable error as the number of poles inspected and other data are not sufficient for accurate estimates.

IX—EXPERIENCE WITH TREATED POLES IN OTHER LOCATIONS

The most extensive studies of the results of pole preservative treatment are those which have been made by the American Telephone and Telegraph Company, working in conjunction with the United States Forest Service. These studies were made on specially prepared groups of experimental poles erected in the lines of the Telephone Company in various parts of the country. Detailed records have been kept of the results of the use of full length treatment by the pressure cylinder process of southern pine poles in two lines, one in Virginia and one in Alabama and Mississippi. Experimental butt treated lines were erected in northern New York, in Georgia and in Nebraska. The results of these studies have been published in Bulletins of the Forest Service and in the paper by F. L. Rhodes and R. F. Hosford already referred to.

Data collected in connection with this work and presented in the paper by Rhodes and Hosford indicate that an increase in life of 5.4 years was obtained in Georgia by the brush treatment of juniper poles with creosote oil. The indicated increase in life of chestnut poles due to brush treatment with creosote oil was 6.6 years in the south and 8.5 years in the north. Cedar poles in Nebraska which had been treated by the brush process with creosote had only been in place five years at the time of the last inspection reported. About 50 per cent of these poles showed decay. Contrary to expectations it was found that there was very little difference in life of "green" and seasoned poles set without treatment. The conclusion was drawn that the principal value of seasoning was as a preparation of the pole for preservative treatment. It was also found that preservative treatment was not as effective if the seasoning process had been continued for too long a time.

The oldest open tank treated poles in the experimental lines were in the Buffalo-Warren line in New York. These were chestnut poles and were treated by the hot and cold process. After eight years of service practically 99 per cent were sound and after eleven years only three per cent showed decay. The results of the inspections of the poles in the Buffalo-Warren line are given in Circular 198 of the Forest Service, in the paper by Rhodes and Hosford, and in an article in *Telephony* of April 3, 1915, by Clyde H. Teesdale. Fig. 18 is drawn from data given in the latter article and shows the per cent of poles showing decay and the average reduction in circumference after eight years of service.

A group of hot and cold bath open tank treated cedar poles was included in the experimental line of the A. T. & T. Company, in Nebraska and inspections after four years service showed 99 per cent sound.

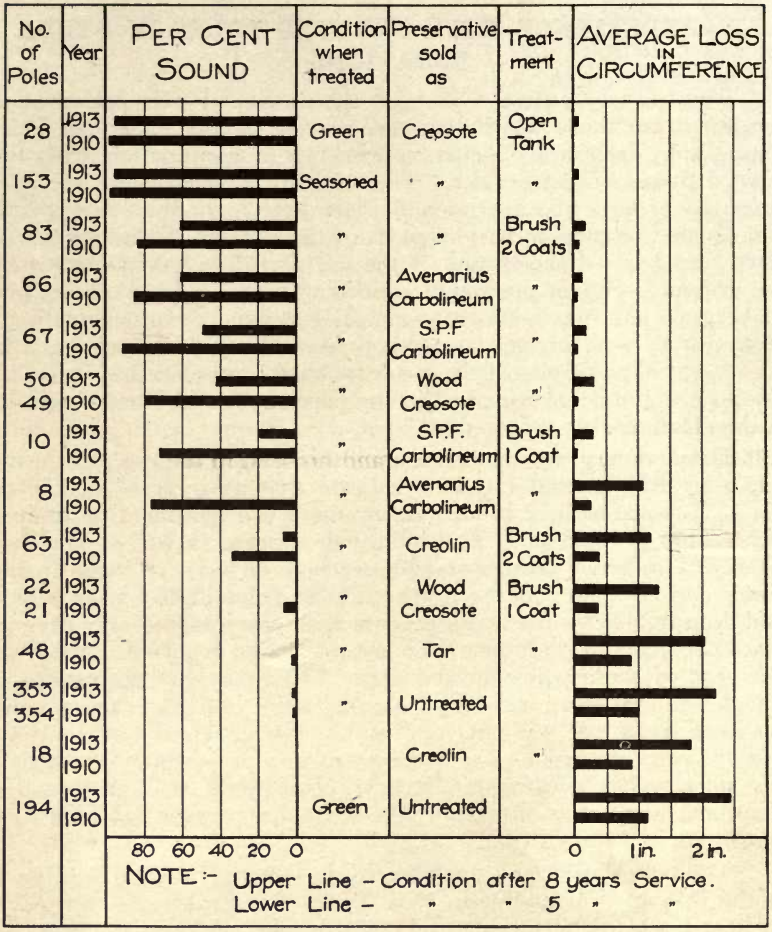
No. of Poles
Year
PER CENT SOUND
Condition when treated
Preservative sold as
Treatment
AVERAGE LOSS IN CIRCUMFERENCE
28 1913 1910 Green Creosote Open Tank
153 1913 1910 Seasoned " "
83 1913 1910 " " Brush 2 Coats
66 1913 1910 " Avenarius Carbolineum "
67 1913 1910 " S.P.F Carbolineum "
50 1913 49 1910 " Wood Creosote "
10 1913 1910 " S.P.F. Carbolineum Brush 1 Coat
8 1913 1910 " Avenarius Carbolineum "
63 1913 1910 " Creolin Brush 2 Coats
22 1913 21 1910 " Wood Creosote Brush 1 Coat
48 1913 1910 " Tar "
353 1913 354 1910 " Untreated
18 1913 1910 Creolin "
194 1913 1910 Green Untreated
80 60 40 20 0
0 1 in. 2 in.
NOTE:- Upper Line - Condition after 8 years Service.
Lower Line - " " 5 " "

Fig. 18. Condition of chestnut poles, Buffalo-Warren Line, after five and eight years.

Pole preservative treatment has been practiced in Europe for much longer periods than in this country and very complete records have been kept of the life of poles with different treatments. Statistics quoted by Weis (Preservation of Structural Timber) taken from records kept for over fifty years in Germany show an average life of 7.7 years for untreated poles and 20.6 years for poles treated with creosote.

X—SUMMARY AND CONCLUSIONS

In conclusion the results of this study may be summarized and the more important points restated briefly.

1. A survey of the State of Indiana was made and showed that a considerable percentage of the poles erected at the present time are receiving some kind of treatment. The majority of pole using companies are either using preservative treatment or planning to use it on future work.

2. The most commonly used preservatives in this country are derivatives of coal tar. Dead oil of coal tar or creosote oil and the higher boiling oils known as carbolineums are the most satisfactory preservatives. Coal tar itself should not be used as it has little value as a preservative, and "mixed creosote oils", those containing undistilled products, can not be recommended.

3. The commonly used treatments in Indiana are the brush treatment and the open tank treatments either by dipping or by the hot and cold process. Poles of less durable woods treated by the pressure tank process are as yet more expensive than butt treated cedar and chestnut poles and so have not come into extensive use.

4. A study of the economic side of pole preservation shows that under average conditions an increase in life of about 2 years will justify brush treatment, about 3.5 years will justify the open tank dipping treatment in hot creosote and about 7.5 years will justify the hot and cold bath open tank treatment. The results of the inspections made in various parts of Indiana, indicate that an increase in life greater than that necessary to justify the treatment may be expected for these treatments if they are applied properly.

5. It is possible to increase the life of poles already in service to some extent by reinforcement and treatment after setting. The most commonly used method is the process of reinforcing by setting a creosoted stub along side the weakened pole and binding the two together by wire. Another method used is that of excavating the earth from around the pole, clearing away decayed wood and applying a brush treatment. Concrete reinforcement has been applied to some extent but on account of the cost can be recommended only for exceptional cases where the cost of replacement of the poles is very large.

6. The selection of the proper method of treatment to be used depends upon local conditions. For the lighter lines and for the smaller companies, or where first cost is an important consideration the brush treatment offers some advantage. The open tank dipping process known as Specification "AA" is preferred by some on account of greater uniformity and probably somewhat longer life than the brush treatment which advantages are considered to overbalance the increased cost. The hot and cold bath open tank treatment gives the greatest increase in life and is particularly suitable for heavy lines and permanent construction.

7. Specifications adopted by various bodies for the purchase of preservatives and specifications for the application of the treatments recommended are included in the appendices.

APPENDIX A

SPECIFICATIONS FOR PRESERVATIVES

American Railway Engineering Association Specifications—Since 1909 the American Railway Engineering Association has had a Standing Committee on Wood Preservation. The work of this committee has dealt mostly with preservation of railroad ties, but its specifications for creosote oils for preservatives have been widely used. Three grades of oil are covered by specifications. The specification for the best grade oil, or Grade 1, as it is designated, as revised in 1912 is as follows:

"The oil used shall be the best obtainable grade of coal tar creosote; that is, it shall be a pure product obtained from coal gas tar or coke oven tar and shall be free from any tar, including coal gas tar or coke oven tar, oil or residue obtained from petroleum or any other source; it shall be completely liquid at thirty eight (38) degrees Centigrade and shall be free from suspended matter; the specific gravity of the oil at thirty-eight (38) degrees Centigrade shall be at least 1.03. When distilled by the common method—that is, using an eight (8) ounce retort, asbestos covered, with standard thermometer, bulb one-half (½) inch above the surface of the oil—the creosote, calculated on the basis of dry oil, shall give no distillate below two hundred (200) degrees Centigrade, nor more than five (5) per cent below two hundred and ten (210) degrees Centigrade, not more than twenty-five (25) per cent below two hundred and thirty-five (235) degrees centigrade, and the residue above three hundred and fifty-five (355) degrees Centigrade, if it exceeds five (5) per cent in quantity, shall be soft. The oil shall not contain more than three (3) per cent water."

The specification for Grade 2 oil is practically the same as for Grade 1, except that the allowable distillate up to two hundred and ten (210) degrees Centigrade is eight (8) per cent, and up to two hundred and thirty-five (235) degrees Centigrade is thirty-five (35) per cent. For Grade 3, the allowable distillate for the same temperatures is ten (10) and forty (40) per cent respectively and the minimum specific gravity is 1.025.

National Electric Light Association Specifications—A committee of the National Electric Light Association for the purpose of studying preservation of poles and cross arms made reports to the 1910 and 1911 convention of the association. The following specifications for preservatives are quoted from the report of this committee adopted at the 1911 convention and printed in the convention proceedings for that year:

"The oil under these specifications must have the following characteristics:

1. It shall have a specific gravity of at least one and three-hundredths (1.03) and not more than one and eight-hundredths (1.08) at thirty-eight degrees Centigrade (38° C.). If the gravity is taken at a higher temperature, a correction of eight ten-thousandths (.0008) for each degree Centigrade above thirty-eight (38) shall be made.
2. There shall be not over one per cent (1%) of residue insoluble in hot benzol.
3. The original oil shall contain not over two per cent (2%) of water.
4. The oil shall be miscible in absolute alcohol, volume for volume.
5. The residue remaining upon sulphonating a portion of the total distillate shall not exceed one per cent (1%).
6. The oil shall contain not more than eight per cent (8%) of tar acids.

7. When two hundred (200) grams of the oil are distilled in accordance with the requirements of the specifications for the analysis of coal tar dead or coal tar creosote hereinafter referred to and results calculated to water free oil:

(a) Not more than five per cent (5%) of oil shall distill off up to two hundred and five degrees Centigrade (205° C.).
(b) Not more than thirty-five per cent (35%) of oil shall distill off up to two hundred and thirty-five degrees Centigrade (235° C.).
(c) Not more than eighty per cent (80%) shall distill off up to three hundred and fifteen degrees Centigrade (315° C.).
(d) The coke residue shall not exceed two per cent (2%).
(e) The distillate between two hundred and five (205) degrees Centigrade and two hundred and thirty-five (235) degrees Centigrade shall deposit napthalene on cooling to fifteen (15) degrees Centigrade.

Note: The percentage distilling to two hundred and forty-five (245) and two hundred and seventy (270) degrees Centigrade shall be noted.

Specifications Covering Oil for Brush Treatments—"The material required under these specifications is the same as that called for under Specification "A" except that it shall have a gravity of between one hundred and eight (1.08) and one hundred and twelve (1.12) at fifteen degrees Centigrade (15° C.). No oil shall distill to two hundred and five degrees (205° C.) and not more than ten per cent (10%) to two hundred and thirty-five degrees Centigrade (235° C.). Not more than one-half of one per cent (½%) of insoluble matter shall be left upon extraction with hot benzol."

United States Shipping Board Emergency Fleet Corporation Specification.

Specification for Creosote Oil for Brush Treating Ship Timbers—The oil shall be obtained from coal-gas or coke-oven tar and shall be free from any tar including coal-gas tar and coke-oven tar, oil or residue obtained from petroleum or other source. It shall comply with the following requirements:

1. It shall be completely liquid at 15 deg. C.
2. It shall contain not more than 2% water.
3. It shall contain not more than 5% of matter insoluble in benzol.
4. The specific gravity of the oil at 15 deg./15.5 deg. C. shall not be less than 1.08.
5. The distillate based on water free oil shall be within the following limits:

Up to 210 deg. C. not more than 1%.
Up to 235 deg. C. not more than 10%.

6. The specific gravity of the fraction between 235 deg. C. and 315 deg. C. shall not be less than 1.03 at 38 deg./15.5 deg. C. The specific gravity of the fraction between 315 deg. C. and 355 deg. C. shall not be less than 1.10 at 38 deg. C./15.5 deg. C.
7. The residue above 355 deg. C. if it exceeds 5% shall have a float test of not more than 50 seconds at 70 deg. C.
8. The oil shall yield not more than 2% coke residue.
9. The foregoing tests shall be made in accordance with the standard methods of the American Wood Preservers' Association.

American Telephone and Telegraph Company's Specification—The American Telephone and Telegraph Company's Specification No. 3782 for dead oil of coal tar for brush and open tank treatments was published in the Proceedings of the 15th Annual Meeting of the American Wood Preservers' Association, and is reproduced by permission.

General—The material desired under these specifications is that known as dead oil of coal tar or coal tar creosote, obtained through the

distillation of bituminous coal tar produced by the destructive distillation of bituminous coal at a temperature high enough to yield a tar consisting mainly of compounds of the aromatic series. It shall be without adulteration.

Information shall be furnished on request as to the origin of the oil and the names of all parties through whose hands it may have passed. A copy of any analysis of the oil that may have been made prior to its offering shall also be furnished. The right is reserved to take representative samples of the oil and test the same wherever desired.

Requirements—All dead oil of coal tar furnished under these specifications shall conform to the following requirements:

1st. The oil shall have a specific gravity of at least one and three-hundredths (1.03) at thirty-eight degrees Centigrade (38° C.).

2nd. The oil shall be thoroughly liquid at a temperature of thirty-eight degrees Centigrade (38° C.).

3rd. When one hundred grams of the oil are distilled in accordance with the requirements of the specifications for the Analysis of Dead Oil of Coal Tar or Coal Tar Creosote hereinafter referred to—

(a) Not more than eight (8) per cent shall distill off up to 210 deg. C.
(b) Not more than thirty-five (35) per cent shall distill off up to 235 deg. C.
(c) Not more than eighty (80) per cent shall distill off up to 315 deg. C.
(d) The oil shall not contain more than two (2) per cent of water.
(e) The quantity of tar acids present in the fractions distilling below 300 deg. C. shall not exceed ten (10) per cent (measured by volume) of the total sample distilled.
(f) The sulphonation residue from the fraction distilling between 300 deg. C. and 360 deg. C. shall not exceed one and one-half (1½) per cent of the said fraction.

4th. The constituents of the oil insoluble in benzol shall not exceed five-tenths (0.5) per cent by weight.

Packing—This oil shall be furnished in tinned iron containers of five (5) gallons capacity or in wooden barrels of approximately fifty (50) gallons capacity as specified in the order.

Subsidiary Specifications—The following specifications form a part of these specifications:

Specifications for the Analysis of Dead Oil of Coal Tar or Coal Tar Creosote.

APPENDIX B

SPECIFICATION FOR THE BUTT TREATMENT OF WOODEN POLES BY THE BRUSH METHOD

For the convenience of those who may wish to use brush treatment, the following specification has been prepared:

Scope of the Specifications—This specification covers the method of application of preservative treatment to the butts of wooden poles commonly known as the brush treatment. The purpose of the treatment is to provide a means of arresting or retarding decay at the ground line of a wooden pole by forming at the surface of the pole a layer of wood which is unfit for the growth of decay producing organisms.

Preservative to Be Used—The preservative to be used shall be .....or an approved equivalent. It shall be supplied in tinned iron containers of ..... gallons capacity or in wood or metal barrels of approximately 50 gallons capacity.

Portion of the Poles to Be Treated—The portion of the pole to be treated shall be the portion extending one foot above and two feet below the ground line of the pole when set at the standard depth for poles of the class and length being treated. It may be advisable to extend the limits above the ground line for poles used in country lines to a line above the growth of vegetation or to the bottom of the poles in soils where decay takes place over the entire portion of the pole below the ground line.

Preparation of Poles for Treatment—The poles to be treated by this method shall be air seasoned. Poles held in storage in the pole yard under proper conditions for six months including the summer months or for nine months including any months of the year should be seasoned properly. Under no conditions shall green timber be treated by this method. Poles which have been wet from rain or snow or from contact with the earth, shall be thoroughly dry before the treatment is applied. All dirt and foreign matter of any kind shall be removed. All decayed or damaged spots or soft and brashy timber shall be shaved until firm, sound wood is exposed. All fine inner bark must be removed whether it adheres closely to the wood or not.

Heating of the Preservatives—Two metal containers of about two (2) gallons capacity, preferably agate or enamelled kettles with covers, shall be used so that one may be heated while the other is being used. The preservative may be heated by the use of the ordinary gasoline or kerosene furnace used by plumbers and cable splicers or by supporting the container on bricks or stones over a slow fire. A Fahrenheit thermometer having a scale up to two hundred and fifty (250) degrees F. should be provided so that the temperature can be maintained within the limits specified under "Methods of Application". The oil should be thoroughly stirred in the original container before it is poured into the kettles for heating.

Method of Application—The purpose of the treatment is to secure as deep penetration as possible into the wood. The preservative shall be maintained at a temperature of not less than one hundred and fifty degrees Fahrenheit (150 deg. F.) and not more than two hundred degrees Fahrenheit (200 deg. F.). The approved means of application is a wire bound bristle brush four to six inches wide with a long handle. A mop may be used as an alternative means of application. The poles shall be placed on skids above the surface of the earth and the oil taken up with the brush and applied liberally to the portion of the pole to be treated. It should be brushed well and after brushing additional oil should be applied to leave the surface wet. Particular attention shall be paid to flooding cracks, season checks and knots. Two coats shall be applied, allowing at least one day between the application of the first and second coats. The poles should not be set until two days after the application of the second coat. As far as possible the work should be done in warm, dry weather so that the preservative does not chill at the surface instead of penetrating.

Where a number of poles are to be treated at one time, it is recommended that several poles be skidded and the upper side of each pole treated. After all the poles on the skids have been treated on the upper side, the poles shall be turned over and the remaining portion treated. This will result in saving of preservative which has been flooded into cracks and checks and it will have time to penetrate before the pole is turned over. If poles have been framed, the tops and gains should be treated at the same time as the butts. If poles are held in the yard for some time before using, a third coat of preservative may be advisable just before the poles are to be placed in service.

Precautions to Be Observed in Applying Preservatives—When applying and handling preservatives, precautions must be observed to prevent fire. Care should be exercised to see that the gasoline or kerosene furnace, if used, is in good condition and free from leaks. Shavings or other refuse of combustible nature must not be allowed to collect near the place where the preservative is being heated. If the preservative catches fire, the fire may be extinguished by placing the cover on the kettle or by the use of sand. A few shovelsful of sand should be placed near the heating apparatus for use in case of fire. Water is not effective for extinguishing the fire as it tends to scatter the burning oil.

Workmen should exercise care that the hot preservative is not splashed or spattered over clothing or exposed portions of the body. The fumes of hot preservative sometimes causes a burning sensation or blisters and it is advisable to protect the hands by the use of gloves and, if necessary, vaseline or lard may be rubbed on exposed portions of the skin. The workman should work from the windward side so that the fumes are blown away from him rather than toward him.

Handling of Treated Poles—As the effectiveness of the treatment as a protection from decay depends upon a comparatively thin layer of treated wood, care must be taken that this treated layer is not damaged in handling a pole that has been treated. Treated poles must not be dragged on the ground. Cant hooks or pole tongs must not be used on the treated portion of the pole or immediately above it. In case the treated portion is damaged, another coat of preservative should be brushed onto the damaged portion before the pole is set.

APPENDIX C

SPECIFICATIONS FOR OPEN TANK DIPPING TREATMENT

The following specifications have been adopted by various companies engaged in butt treating Northern White Cedar and Western Red Cedar poles:

TREATMENT "A"—Carbolineum as Preservative

Condition and Preparation of Poles for Butt-Treatment—Poles shall be seasoned at least four seasoning months before treatment. (See Seasoning Calendar, Appendix D.). All fibrous inner bark and foreign substances must be thoroughly removed from that portion of the pole between the points one and one-half feet above, and one and one-half feet below the ground line. (For ground line see Appendix D.)

Method and Duration of Treatment—The poles shall then be placed in an upright tank with the butts fully and continuously submerged in the preservative, to the height as shown in table (Appendix D), for not less than fifteen minutes when the atmospheric temperature is 70 deg. F. or higher, and a proportionately longer time when the temperature is below that point; that is, during the colder weather the time of immersion must be sufficiently longer to result in the wood becoming as thoroughly heated as it would be under a fifteen-minute treatment when the atmospheric temperature is 70 deg. F. or higher.

Preservative—The preservative is to be that known as "Carbolineum," which must conform to the accompanying specifications.

Temperature of the Preservative—The preservative shall be heated to a temperature of 215 deg. F. at least once every four hours of treatment, and shall not be allowed to fall below 180 deg. F. or reach above 230 deg. F.

Derivation of Carbolineum—The carbolineum shall consist of the higher boiling factions of pure coal tar and must not contain any ad-

mixture of any other tar oil or residue obtained from petroleum or any other source.

Specific Gravity—The specific gravity of the oil compared with water at 15.5 deg. C. shall not be more than 1.135 nor less than 1.09 at 38 deg. C.

Flashing Point—The flashing point shall not, in general, be below 140 deg. C.

Burning Point—The burning point shall not, in general, be below 170 deg. C.

Fractional Distillation—The amount of distillate coming over at 300 deg. C. shall not exceed 15%, of which not to exceed 2% shall distill below 235 deg. C.

Tar Acid Content—The tar acid in the distillate coming over below 300 deg. C. shall not exceed 2% by volume of entire sample.

Sulphonation Test for Impurities—A sulphonation test of the fraction between 300 deg. C. and 360 deg. C. should yield in residue not more than one-tenth of 1% by volume of entire sample.

Insoluble Residue—The percentage of residue insoluble in benzol shall not exceed .25 of 1% by weight.

TREATMENT "AA"—Creosote as a Preservative

Condition and Preparation of Poles for Butt-Treatment—Poles shall be seasoned at least four seasoning months before treatment. All fibrous inner bark and foreign substances must be thoroughly removed from that portion of the pole between the points one and one-half feet above, and one and one-half feet below the ground line. (For ground line see Appendix D.)

Method and Duration of Treatment—The poles shall then be placed in an upright tank with the butts fully and continuously submerged in the preservative, to the height as shown in table (Appendix D), for not less than fifteen minutes when the atmospheric temperature is 70 deg. F. or higher and a proportionately longer time when the temperature is below that point; that is, during the colder weather the time for immersion must be sufficiently longer to result in the wood becoming as thoroughly heated as it would be under a fifteen-minute treatment when the atmospheric temperature is 70 deg. F. or higher.

Preservative—The preservative is to be that known as "Creosote," which must conform to the accompanying specifications.

Temperature of the Preservative—The preservative shall be heated to a temperature of 215 deg. F. at least once every four hours of treatment, and shall not be allowed to fall below 180 deg. F. or reach above 230 deg. F.

Derivation of Creosote—The creosote shall be a coal tar distillate obtained entirely from coal-gas or coke-oven tar and must not contain any admixture of any other tar, oil or residue obtained from petroleum or any other source, including coal-gas tar or coke-oven tar. The oil must be completely liquid at 38 deg. C., and shall be free from suspended matter.

Specific Gravity—The specific gravity of the oil shall not be more than 1.08 or less than 1.03 at 38 deg. C.

Water Content—The oil shall not contain more than 3% water.

Fractional Distillation—Up to 200 deg. C. the water-free oil shall render no distillate whatever.

Up to 210 deg. C. the amount of distillate shall not exceed 5%.

Up to 235 deg. C. the amount of distillate shall not exceed 25%.

At 355 deg. C. the residue if it exceeds 5% in quantity shall be soft.

Tar Acid Content—The tar acids in the distillate coming over below 300 deg. C. shall not exceed 8% by volume of the entire sample.

APPENDIX D

SPECIFICATIONS FOR HOT AND COLD BATH OPEN TANK TREATMENT

Specifications of American Telephone and Telegraph Company

Butt Treatment of Poles—These specifications describe a method for treating the entire butt section of a pole for the purpose of prolonging its serviceable life. The preservative treatment is applied only to that part of the pole which is exposed to contact with the soil. The treatment should, therefore, only be used upon poles cut from timbers which are not appreciably subject to decay when exposed in the open air above the surface of the soil.

Materials: Poles—Poles treated under these specifications shall conform to all of the requirements of the specifications and drawings covering untreated poles of the timber referred to in the order. If it is desired that only seasoned poles be treated, the order should be worded to call for seasoned treated poles.

Dead Oil of Coal Tar—The deal oil of coal tar used for impregnating poles ordered under these specifications shall conform to the requirements of the Specifications for Dead Oil of Coal Tar for Brush and Open Tank Treatments hereinafter referred to. Samples of oil intended for use under these specifications may be taken whenever desired from any container in which it is being stored or used. The right is reserved to test samples of oil thus collected wherever desired.

Preparation for Treatment—All outer and inner bark shall be completely removed from all parts of the surfaces of the pole which are hereinafter required to be impregnated with preservative. All poles which are held for seasoning shall be stacked on land from which the underbrush has been removed. The bottom layer of any pile of poles held for seasoning shall be supported upon skids in such a manner that no part of the pole shall be less than one (1) foot above the surface of the ground or any vegetation growing thereon. The poles shall be stacked in open piles in such a manner as to permit the free circulation of air around each individual pole.

Classification for Treatment—Poles cut from different kinds of timber shall not be treated in the same charge. Poles differing in length shall not be treated in the same charge, unless there is no difference in the minimum lengths of the section to be treated hereinafter specified for them.

Seasoning—Poles cut from the same kind of timber and not differing with respect to length so as to preclude their treatment in the same charge shall be subdivided into classes for separate treatments with respect to their period of seasoning as follows:

Duration of Holding Period

Seasoning Class	When Poles are Held in a Location North of the 38th° of Latitude	When Poles are Held in a Location South of the 38th° of Latitude
S (Seasoned)	Poles which have been held either from April 1 to October 1 or for not less than nine months.	Poles which have been held either from May 1 to September 1 or for not less than six months.
P (Partially seasoned)	Poles which have been held for at least three months between April 1 and October 1 or for not less than six months.	Poles which have been held for at least two months between April 1 and October 1 or for not less than four months.
G (Green)	Poles not included in either of the above classes.	Poles not included in either of the above classes.

Poles belonging to different classes with respect to seasoning shall not be treated in the same charge. When orders call for furnishing seasoned treated poles, only poles belonging to Class S shall be furnished.

Method of Treatment.

Length of Section to Be Treated—Poles shall be so placed in the treating tank as to keep immersed in the oil throughout the treating processes their entire surfaces below a plane whose distance from the butt shall not be less than that given in the following table:

Length of Pole.	Minimum Length of Treated Section, Measured from Butt of Pole.
20 ft.	5½ ft.
22 ft.	6 ft.
25 ft.	6 ft.
30 ft.	6½ ft.
35 ft.	7 ft.
40 ft.	7 ft.
45 ft.	7½ ft.
50 ft.	8 ft.
55 ft.	8½ ft.
60 ft.	9 ft.
65 ft.	9½ ft.
70 ft.	10 ft.

Hot Oil Treatment—Poles shall first be held in a bath of hot dead oil of coal tar for a period which shall not be less than that given in the following table for the seasoning class to which the poles belong:

Seasoning Class.	Minimum Duration of Hot Oil Treatment.
S (Seasoned)	4 hours
P (Partially seasoned).	6 hours
G (Green)	8 hours

Poles belonging to Classes S and P which have been wet by rain or snow within less than three (3) days previous to the time of treatment shall be treated as required for Class G.

The treatment in hot oil shall not in any event be stopped until the giving off from the poles of bubbles of air or water vapor has practically ceased.

During the treatment with hot oil, the temperature of the bath of dead oil of coal tar shall not be less than 212° Fahrenheit, nor more than 230° Fahrenheit.

Cool Oil Treatment—After the conclusion of the treatment with hot oil hereinafter specified, the treatment of the poles shall be continued through immersion in cool oil in accordance with one of the following methods:

1. Continued immersion of the poles in the hot oil bath until the latter has cooled to the temperature hereinafter specified.
2. Mechanical transfer of the poles from the hot oil bath to a bath of cool oil in accordance with the conditions hereinafter specified.
3. Withdrawal of the hot oil and substitution of cool oil in accordance with the conditions hereinafter specified.

When this part of the treatment is applied by allowing the hot oil bath to cool, the poles shall be kept in the cooling oil until its temperature has fallen to below 110° Fahrenheit and in no case for less than five (5) hours.

When the cool oil treatment is applied through the mechanical transfer of a pole from the hot oil bath to the cool oil bath, the period of time elapsing between the beginning of the removal of the pole from the bath of hot oil and its immersion to the minimum required depth in the bath of cool oil shall not exceed three (3) minutes. Poles shall be held in the bath of cool oil for not less than three (3) hours. The temperature of the bath during the period of immersion shall be at least ten degrees (10°) Fahrenheit in excess of the temperature at which solids separate from the oil used for treatment, but shall not be higher than one hundred and ten degrees (110°) Fahrenheit.

When the cool oil treatment is applied through substitution of cool oil for the hot oil originally in the treating tank, the substitution of cool oil shall either be made without lowering the level of the oil surrounding

the poles or the period of time elapsing between the beginning of the removal of the hot oil from the treating tank and the filling of the tank with cool oil sufficient to immerse the poles to the minimum length hereinafter specified, shall not be more than three (3) minutes. The poles shall be held in the bath of cool oil for not less than three (3) hours. The temperature of the bath during the period of immersion shall be at least ten degrees (10°) Fahrenheit in excess of the temperature at which solids separate from the oil used for treatment, but shall not be higher than one hundred and ten degrees (110°) Fahrenheit.

Draining Poles—After the immersion in cool oil as hereinbefore specified has been finished the poles shall be removed from the bath of oil, or the oil shall be removed from the treating tank. Poles may be held in the treating tank until the dripping of unabsorbed oil has ceased.

Depth of Impregnation—The depth of penetration in the treated section of any pole shall not be less than one-quarter (¼) of an inch when the thickness of the sapwood is one-half (½) of an inch or more. When the thickness of the sapwood is less than one-half (½) of an inch, the depth of penetration shall not be less than one-half of the thickness of the sapwood. Borings to determine depth of penetration shall be made with an increment borer. The bore hole shall be filled with hot dead oil of coal tar. As soon as the oil has been absorbed a creosote wooden plug conforming to the drawing hereinafter referred to shall be driven in so as to completely fill the bore hole.

Storage of Treated Poles—If for any reason the treated poles have to be held in storage for more than two weeks, they shall be stacked in close piles upon skids. The skids shall be of such strength and such dimensions as to support the poles without producing noticeable distortion of any of them. The skids shall be of such height that no part of any pole shall be less than one (1) foot above the surface of the soil or the top of any vegetation growing thereon.

Handling of Treated Poles—The protection of butt-treated poles from decay is dependent upon the continuity of a relatively thin treated layer which has been impregnated with preservative. Care shall therefore be taken to avoid injury of the treated butt when the poles are moved to new locations. Treated poles shall not be dragged along the ground. Cant hooks, pole tongs and other tools which might cut or bruise the surface layers of poles shall not under any conditions be applied to the treated section.

Subsidiary Specifications and Drawings—The following specifications and drawings form a part of these specifications:

Specifications for Deal Oil of Coal Tar for Brush and Open Tank Treatments.

Drawing No. 92-E-74, "Wooden Plug for Use with Increment Borer."

TREATMENT "B"—Creosote as a Preservative

Specifications for Butt Treatment of Poles—Treatment "B", Alternate Hot and Cold Treatment for a Minimum Duration of Six Hours—Creosote as Preservative.

Condition and Preparation of Poles for Butt Treatment—Poles shall be seasoned at least four seasoning months before treatment. (See Seasoning Calendar below.) All fibrous inner bark and foreign substances must be thoroughly removed from that portion of the pole between the points one and one-half feet above, and one and one-half feet below the ground line. (For ground line see bottom of next page.)

Method and Duration of Treatment—The poles shall be placed in upright tanks with the butts fully and continuously submerged in the preservative, to the height as shown in table on this page. The duration of

treatment shall be divided between a hot and cold bath. The poles shall remain in the hot bath for four continuous hours, after which they shall be transferred to the cold bath in which they shall remain for two hours. (See Note.)

Preservative—The preservative is to be that known as "Creosote," which must conform to the specifications shown on page 45.

Temperature of the Preservative—The preservative constituting the hot bath shall be heated to a temperature of 212 deg. F. at least once every four hours and shall not be allowed to fall below 180 deg. F. or reach above 230 deg. F.

The temperature of the preservative constituting the cold bath shall not exceed 112 deg. F. at the conclusion of the treatment.

Note: The intent of treatment "B" is to give poles as near a full sap penetration as possible. Experience has shown that, due to the variance in the density of the sap wood, some poles will not take a penetration as readily as others, but at least 75% of the poles shall have an average penetration of one-half the sap wood. If necessary the duration of treatment shall be extended to accomplish this result.

Seasoning Calendar—Poles that have been properly piled for seasoning for a period of four seasoning months shall be considered seasoned. In arriving at a seasoning month, the calendar months shall be rated as follows:

January	equals ⅛ seasoning mo.	July	equals 1 seasoning mo.
February	equals ⅛ seasoning mo.	August	equals 1 seasoning mo.
March	equals ¼ seasoning mo.	September	equals 1 seasoning mo.
April	equals ½ seasoning mo.	October	equals ¾ seasoning mo.
May	equals ¾ seasoning mo.	November	equals ⅜ seasoning mo.
June	equals 1 seasoning mo.	December	equals ⅛ seasoning mo.

Ground Line and Height of Treatment

Length of poles	Ground line	Height of treatment	Length of poles	Ground line	Height of treatment
16 ft.	3 ft. 6 in.	5 ft.	45 ft.	6 ft. 6 in.	8 ft.
18 ft.	3 ft. 6 in.	5 ft.	50 ft.	6 ft. 6 in.	8 ft.
20 ft.	3 ft. 6 in.	5 ft.	55 ft.	6 ft. 6 in.	8 ft.
25 ft.	4 ft. 6 in.	6 ft.	60 ft.	7 ft.	8 ft. 6 in.
30 ft.	5 ft. 6 in.	7 ft.	65 ft.	7 ft. 6 in.	9 ft.
35 ft.	6 ft.	7 ft. 6 in.	70 ft.	7 ft. 6 in.	9 ft.
40 ft.	6 ft.	7 ft. 6 in.	75 ft.	7 ft. 6 in.	9 ft.
			80 ft.	7 ft. 6 in.	9 ft.

APPENDIX E

BIBLIOGRAPHY

The following is a selected list of publications on pole preservation. Reference may be made to them for more extended discussion of various phases of the subject.

References on General Subject of Wood Preservation:

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Open Tank Method of Treatment of Timbers—by Carl G. Crawford, Forest Service Circular 101, July 2, 1907.

American Railway Engineering Association Proceedings of Annual Conventions—1910, 1911.

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Seasoning to Telephone and Telegraph Poles—by Henry Grinell, Forest Service Circular No. 103, June 6, 1907.

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